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This background document provides the Agency's rationale and technical support for selecting the constituents regulated in F019 nonwastewatersand wastewaters and for developing proposed BDAT standards for those regulated constituents. This document is an addendum to the support BDAT background document for cyanide wastes (F006-F012), June 1989.

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PROPOSED

ADDENDUM FOR F019 TO THE BDAT BACKGROUND DOCUMENT FOR CYANIDE WASTES

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November 1989

ADDENDUM FOR F019 TO THE BDAT BACKGROUND DOCUMENT FOR CYANIDE WASTES

1. EXECUTIVE SUMMARY

This document provides the Agency's rationale and technical support for selecting the constituents to be regulated in F019 nonwastewaters and wastewaters and for developing proposed best demonstrated available technology (BDAT) treatment standards for those regulated constituents. This document is an addendum to the supporting BDAT background document for cyanide wastes (F006-F012) dated June 1989.

According to 40 CFR 261.31, waste code F019 is generated from the chemical conversion coating process and is listed as "wastewater treatment sludges from chemical conversion coating of aluminum." The waste as generated is typically, by BDAT definition, a nonwastewater since it usually contains greater than 1 percent total suspended solids (TSS). (For the purpose of determining the applicability of the treatment standards, wastewaters are defined as wastes containing less than 1 percent (weight basis) total suspended solids and less than 1 percent (weight basis) total organic carbon (TOC). Wastes not meeting this definition are nonwastewaters.) The Agency has determined that BDAT for F019 nonwastewaters and wastewaters is wet air oxidation for cyanide followed by chemical reduction, precipitation, filtration, and stabilization for metals (chromium).

Table 1-1 summarizes the proposed treatment standards for F019 nonwastewaters and wastewaters.

Table 1-1 Proposed BDAT Treatment Standards for F019

Constituent	Maximum for any single grab sample		
	Nonwastewater		Wastewater
	Total concentration (mg/kg)	TCLP leachate concentration (mg/l)	Total concentration (mg/l)
Cyanide (amenable)	390	NA	0.11
Cyanide (total)	390	NA	0.27
Chromium (total)	NA	5.2	0.32

NA - Not applicable.

2. INDUSTRIES AFFECTED AND WASTE CHARACTERIZATION

The following waste from chemical conversion coating operations in the metal finishing industry, defined in 40 CFR 261.31, is subject to the land disposal restriction prohibitions of RCRA according to the schedule shown in 40 CFR 268.10-11:

F019: Wastewater treatment sludge from the chemical conversion coating of aluminum

Section 2.1 describes the industries affected by the land disposal restrictions for F019 and presents a description of the chemical conversion coating process. Section 2.2 summarizes the available waste characterization data for this waste code. The listed wastes F006-F012, generated from electroplating (common metals electroplating, anodizing, chemical etching and milling, and metal cleaning and stripping) and metal heat treating operations, were addressed in the Best Demonstrated Available Technology (BDAT) Background Document for Cyanide Wastes (USEPA 1989c).

2.1 Industries Affected and Process Description

The listed waste F019 is generated from chemical conversion coating of aluminum. Facilities using chemical conversion coating operations are considered by EPA to be part of the metal finishing industry. In the preamble to the Effluent Limitations Guidelines for the Metal Finishing Industry (48 FR 32482, July 15, 1983), the Agency identified 13,500 facilities in the metal finishing industry, which may use any of 46 electroplating and metal finishing unit operations (including electroplating, heat treating, and chemical conversion coating).

Users of chemical conversion coating operations generally fall under Standard Industrial Classification (SIC) code series 3000, which

comprises fabricated metal products except machinery and transportation equipment; machinery except electrical; electrical and electronic machinery, equipment, and supplies; transportation equipment; measuring, analyzing, and controlling instruments; and miscellaneous manufacturing industries.

Chemical conversion coating operations include the following metal finishing processes: chromating, phosphating, metal coloring, and passivating. In chemical conversion coating operations, a portion of the base metal is converted to a protective film formed by the coating solution.

In chromating, aqueous solutions containing hexavalent chromium and other active organic or inorganic compounds are used to apply a hard surface coating that is corrosion resistant. Chromate coatings are generally applied only to aluminum surfaces, but can also be applied to galvanized surfaces. Phosphating and coloring involve formation of surface metallic phosphates, oxides, or other compounds that impart a color to the metal while also forming a protective coating. Phosphate conversion coatings are primarily used on steel and galvanized surfaces, but can be applied to aluminum. Oxide coatings (coloring) are applied primarily to galvanized surfaces. Passivating is the formation of a protective film on metals, particularly stainless steel and copper, by immersion in acid, cyanide, or aqueous organic chemical solutions.

Chromating is the most common chemical conversion coating process used to apply a coating to aluminum parts. Chromate coatings are applied from acid solution containing a source of hexavalent chromium (e.g., sodium chromate or chromic acid) and a strong oxidant (e.g., hydrofluoric acid or nitric acid). Chromate films are formed by the reaction of hexavalent chromium with the metal surface. Certain anions, referred to as "activators," are necessary for the formation of chromate coatings. Cyanide is used as an activator, usually in the form of ferricyanide

$(Fe(CN)_6)^{-3}$ ion. Other anions commonly used as activators include acetates, formates, sulfates, chlorides, fluorides, nitrates, phosphates, and sulfamate ions (USEPA 1982).

Following application of chemical conversion coatings, the parts are usually rinsed in a bath or with a water spray. Wastewaters could be generated from chemical conversion coating operations as rinsewaters or as spent solutions. These wastes contain hexavalent chromium and may contain cyanide. Wastewater treatment sludges generated from treatment of these wastes are the listed waste F019.

2.3 Waste Characterization

This section presents the waste characterization data available to the Agency for F019 waste. The major constituents of this waste and their approximate concentrations are summarized in Table 2-1. Table 2-2 presents the concentrations for BDAT list constituents and other parameters identified as constituents of F019 wastes.

Table 2-1 Approximate Major Constituent Analysis of F019 Waste, as Generated

Constituent	Concentration (percent)
BDAT list metals:	
Chromium (total)	<0.1 - 9
Zinc	<0.1 - 3
Other BDAT list metals	<0.1
Cyanide (total)	<0.1 - 0.4
Other solids (e.g., filter aid)	2 - 35
Water	65 - 98
Total	100%

Table 2-2 F019 Waste Composition Data

Constituent/parameter (units)	Concentration (source)																
	(1)	(2)	(2)	(3)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
BOAT Inorganics Other Than Metals (mg/kg)																	
Cyanide (total)	2,470	7.76	3.93	-	<0.22	-	<4	<4	-	<0.001	<0.001	0.24	0.12	<0.10	3,824	1.35	<0.08
Cyanide (amenable)	I	7.76	ND	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BOAT Metals (mg/kg)																	
Arsenic	9.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barium	21.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium	0.09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	7.24	0.212	0.288	-	<2	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (hexavalent)	3.76	-	-	-	-	-	<0.04	<0.2	-	-	-	-	-	28	-	<0.01	-
Chromium (total)	10,700	6,540	150	289	8,400	23,000	34,800	9,490	16,500	14,000	14	14,430	8,330	25	-	<0.23	-
Copper	1.19	-	-	-	-	-	-	-	-	-	-	-	-	49,000	3,352	3,700	90,000
Lead	-	-	-	<17	<60	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	0.19	-	-	-	-	-	-	-	-	-	-	-	-	8.4	-	41	-
Nickel	1.65	3.25	3.08		<4	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	6.69	-	-	-	-	-	-	-	-	-	-	-	-	39	-	47	-
Zinc	31,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Parameters																	
Total solids (percent)	20.2	-	-	-	-	20-35	-	-	20	32	2	30	20	28	2	-	-

- = Not analyzed.
ND = Concentration reported as "zero."
I = Not determined because of analytical interference.

References:

(1) Zimpro 1989.
(2) MRI 1987.
(3) AES 1981.
(4) Versar 1986. Compilation of data from EPA delisting petitions.

3. APPLICABLE/DEMONSTRATED TREATMENT TECHNOLOGIES

The applicable and demonstrated treatment technologies for cyanide wastes were discussed in detail in the original cyanide wastes background document. None of the technologies identified as demonstrated for cyanide treatment for the other metal finishing cyanide wastes (F006-F012) were found to be demonstrated for F019, based on the treatment data available to EPA at the time.

Technologies for treatment of BDAT list metals in F019 are also discussed in the original background document. The applicable and demonstrated technologies that EPA has identified for metals treatment in F019 wastes are chemical reduction, chemical precipitation, filtration, and stabilization.

3.1 Applicable Treatment Technologies for Cyanide

The technologies applicable to treatment of cyanide in F019 wastes are those technologies that treat cyanide in the complexed form. The Agency has identified wet air oxidation and ultraviolet-light-enhanced ozonation (UV/ozonation) as applicable for treatment of complexed cyanide in F019 wastes.

Wet air oxidation is a high-temperature, high-pressure oxidation process in which the oxidizing agent is dissolved oxygen. At elevated temperatures, oxygen is an effective oxidizing agent for wastes containing organics or oxidizable inorganics such as cyanide. Typical operating temperatures for the treatment process range from 175 to 325°C (approximately 350 to 620°F). The pressure is maintained at a level high enough to prevent excessive evaporation of the liquid phase at the selected operating temperature (generally between 300 and

3,000 psi). At these elevated temperatures and pressures, the solubility of oxygen in water is dramatically increased, thus providing a strong driving force for the oxidation reactions.

UV/ozonation is a chemical oxidation process in which the oxidizing agent is dissolved ozone (supplied as an O_3/O_2 mixture). Ozone is a much stronger oxidizing agent than oxygen. Because it is very unstable, however, it must be generated just prior to being fed to the oxidation reactor. Ozone addition is controlled similarly to the addition of chlorine in alkaline chlorination. Ultraviolet (UV) light enhances the rate of the ozone oxidation reaction. Ultraviolet light is supplied by immersion of UV lamps in the solution. Wet air oxidation and chemical oxidation (by ozone and other oxidizing agents) are described in the Treatment Technology Background Document (USEPA 1989b).

Incineration is not considered applicable for treatment of cyanide in F019 wastes because these wastes are normally generated as inorganic wastewater treatment sludges. EPA would, however, consider incineration as applicable to treatment of F019 wastes containing significant concentrations of oil and grease or organic constituents.

EPA believes, as was detailed in the background document for cyanide wastes, that the treatment technologies applicable for treatment of cyanides (especially complexed cyanides) in wastewater treatment sludges such as F019 are also applicable for treatment of the wastewaters from which these sludges are generated. In fact, the Agency believes that the most effective treatment for cyanide in F019 wastes and other wastewater treatment sludges containing cyanide is to treat the wastewaters for cyanide by one of the applicable technologies <u>before</u> generation of the wastewater treatment sludge because the applicable cyanide treatment

technologies discussed above are designed to treat aqueous waste streams. (See the development of nonwastewater cyanide treatment standards for F006-F012 as detailed in the BDAT background document for cyanide wastes (USEPA 1989c).)

3.2 Demonstrated Treatment Technologies for Cyanide

EPA has identified wet air oxidation and UV/ozonation as demonstrated treatment technologies for cyanide in F019 wastes. Wet air oxidation is in commercial use at several facilities for treatment of wastes containing organics and cyanide. EPA believes that ozonation is currently used commercially for treatment of wastes containing organic constituents and could be applied commercially to cyanide wastes.

4. PERFORMANCE DATA BASE

In Section 2 of this document, generation and characterization of waste code F019 were discussed. This waste is generated as a wastewater treatment sludge from treatment of chromate conversion coating solutions that contain hexavalent chromium and may also contain dissolved ferricyanide compounds. In Section 3, applicable and demonstrated technologies for cyanide and metals were discussed. Applicable technologies for cyanide were specified on the basis of treatment of waste conversion coating solutions before generation of the wastewater treatment sludge, as well as on the basis of applicability to treatment of cyanide in the sludge.

This section presents the data available to EPA on treatment of complexed cyanide wastes, such as F019 and similar wastes. Wastes similar to F019 are wastes that contain cyanide primarily in the complexed form.

4.1 Cyanide Treatment Data

The BDAT background document for cyanide wastes (USEPA 1989c) presented the data available to the Agency at the time on the treatment of cyanide wastes. Since promulgation of the Second Third land disposal restrictions, EPA has tested two technologies, wet air oxidation and UV/ozonation, for treatment of F019 waste and a similar waste containing complexed iron cyanides. Table 4-1 (at the end of this section) presents the results of a bench-scale batch wet air oxidation treatment test of F019 waste. The waste tested was an F019 filter cake generated at an aluminum conversion coating facility. The waste was slurried with water before wet air oxidation treatment. The treated wastewater and treated nonwastewater are the residuals generated following subsequent chemical precipitation and filtration treatment.

Table 4-2 presents the results of bench-scale testing of UV/ozonation treatment of an F009 waste in which the cyanide content was complexed cyanide. This waste was collected at an electroplating facility after destruction of amenable cyanide by alkaline chlorination treatment. EPA feels that this waste is similar to wastewaters from chemical conversion coating of aluminum because the cyanide content of both wastes is primarily in the complexed form. Also, this waste was generated from a similar process in the metal finishing industry and did not contain significant concentrations of other oxidizable compounds.

The data in Table 4-2 give the untreated and treated total waste composition for total cyanide before and after UV/ozonation treatment. The residuals from UV/ozonation treatment were not treated for metals removal; therefore, no data are presented for BDAT list metals and no data are available to indicate how much of the cyanide remaining after UV/ozonation would be found in either wastewater or nonwastewater residuals.

4.2 BDAT List Metals Treatment Data

4.2.1 Wastewaters

No performance data are available for treatment of F019 wastewaters for metals. EPA would expect F019 wastewaters to be similar in waste characteristics to K062 wastewaters in terms of the type and concentration of metals present. The K062 wastewaters tested by the Agency had chromium concentrations of up to 7000 mg/l, and F019 wastewaters would be expected to contain similar concentrations of chromium, as indicated in Tables 2-1 and 2-2 by the high concentration of chromium in the wastewater treatment sludges generated from treatment of these wastewaters. Both wastes are generated from metal finishing processes in which no organics would be expected to be present. Data for

treatment of K062 by chemical reduction followed by chemical precipitation and filtration are presented in Table 4-3.

4.2.2 Nonwastewaters

No performance data are available for treatment of metals in F019 nonwastewaters. (Wet air oxidation and UV/ozonation do not treat the metals in the wastes.) However, data are available for stabilization of metals in F006 (wastewater treatment sludges from electroplating operations). Both of these wastes are wastewater treatment sludges generated from metal finishing operations and are expected to have similar chemical compositions. Treatment data from F006 waste show chromium present at up to 43,000 mg/kg, which is a level comparable to that expected to be found in F019 nonwastewaters (see Tables 2-1 and 2-2). Neither waste is expected to contain concentrations of organic compounds that would affect stabilization treatment. Therefore, the Agency believes that the F006 treatment data sets represent a level of treatment performance that can be achieved for metals in F019 nonwastewaters using stabilization. The performance data for stabilization of F006 appear in Table 4-4.

Table 4-1 Wet Air Oxidation Data for Treatment of F019

Sample Set #1

Constituent/parameter	Concentration: Untreated waste (mg/l)	Concentration: Treated wastewater (mg/l)	Concentration: Treated filter cake (mg/kg)
BDAT Inorganics Other Than Metals			
Cyanide (amenable)	241	5.0	22.9
Cyanide (total)	293	5.07	22.9
Fluoride	38.9	24.7	0.17
Sulfide	<1.0	<1.0	-
BDAT List Metals			
Antimony	<0.005	<0.005	465
Arsenic	0.08	0.13	114
Barium	2.7	0.21	138
Beryllium	0.007	<0.001	0.32
Cadmium	2.1	0.013	102
Chromium (total)	1,230	1.9	72,800
Copper	0.36	0.053	48.7
Lead	14.7	0.003	816
Mercury	0.00035	0.0011	<0.02
Nickel	0.88	0.007	46
Selenium	0.05	0.25	<20
Thallium	<0.14	0.0095	<5
Vanadium	0.31	0.006	<0.5
Zinc	4,900	4.6	261,000
Non-BDAT List Metals			
Iron	190	0.13	12,000
Other Parameters (units)			
COD (mg/l)	10,500	1,750	-
pH (-)	8.54	7.95	-

Parameter (units)	Design value	Operating value
Design and Operating Parameters		
Oxidation Temperature (°C)	NA	200
Time at Temperature (min)	60	60

- = Not analyzed.
NA = Not applicable.
Reference: Zimpro 1989.

Table 4-1 (continued)

Sample Set #2

Constituent/parameter	Concentration: Untreated waste (mg/l)	Concentration: Treated wastewater (mg/l)	Concentration: Treated filter cake (mg/kg)
BDAT Inorganics Other Than Metals			
Cyanide (amenable)	241	<0.02	142
Cyanide (total)	293	0.058	142
Fluoride	38.9	30.9	0.15
Sulfide	<1.0	<1.0	-
BDAT List Metals			
Antimony	<0.005	<0.005	460
Arsenic	0.08	0.22	135
Barium	2.7	0.35	145
Beryllium	0.007	<0.001	0.29
Cadmium	2.1	0.007	99
Chromium (total)	1,230	1.9	68,600
Copper	0.36	0.046	34
Lead	14.7	0.008	586
Mercury	0.00035	0.001	<0.02
Nickel	0.88	0.011	43
Selenium	0.05	<0.005	<20
Thallium	<0.14	0.005	<5
Vanadium	0.31	<0.005	<0.5
Zinc	4,900	4.6	257,000
Non-BDAT List Metals			
Iron	190	0.08	11,000
Other Parameters (units)			
COD (mg/l)	10,500	3,040	-
pH (-)	8.54	7.90	-

Design and Operating Parameters

Parameter (units)	Design value	Operating value
Oxidation Temperature (°C)	NA	240
Time at Temperature (min)	60	60

- = Not analyzed.
NA = Not applicable.
Reference: Zimpro 1989.

Table 4-1 (continued)

Sample Set #3

Constituent/parameter	Concentration: Untreated waste (mg/l)	Concentration: Treated wastewater (mg/l)	Concentration: Treated filter cake (mg/kg)
BDAT Inorganics Other Than Metals			
Cyanide (amenable)	241	<0.02	18
Cyanide (total)	293	0.133	18
Fluoride	38.9	38.9	0.23
Sulfide	<1.0	<1.0	-
BDAT List Metals			
Antimony	<0.005	<0.005	469
Arsenic	0.08	<0.005	109
Barium	2.7	0.77	166
Beryllium	0.007	<0.01	0.32
Cadmium	2.1	<0.04	105
Chromium (total)	1,230	24	74,100
Copper	0.36	0.12	66
Lead	14.7	0.916	584
Mercury	0.00035	0.0008	<0.02
Nickel	0.88	0.21	48
Selenium	0.05	<0.005	<20
Thallium	<0.14	0.005	<5.0
Vanadium	0.31	<0.05	<0.5
Zinc	4,900	15.2	279,000
Non-BDAT List Metals			
Iron	190	0.08	15,200
Other Parameters (units)			
COD (mg/l)	10,500	2,120	-
pH (-)	8.54	7.8	-

Design and Operating Parameters

Parameter (units)	Design value	Operating value
Oxidation Temperature (°C)	NA	280
Time at Temperature (min)	60	60

- = Not analyzed.
NA = Not applicable.
Reference: Zimpro 1989.

Table 4-2 Performance Data for UV/Ozonation Treatment of Complexed Cyanide F009 Waste

Constituent	Concentration	
	Untreated waste (mg/l)	Treated waste (mg/l)
Sample Set No. 1		
Cyanide (total)	61	53
Sample Set No. 2		
Cyanide (total)	61	53
Sample Set No. 3		
Cyanide (total)	61	36
Sample Set No. 4		
Cyanide (total)	61	49
Sample Set No. 5		
Cyanide (total)	61	37
Sample Set No. 6		
Cyanide (total)	61	63
Sample Set No. 7		
Cyanide (total)	61	25
Sample Set No. 8		
Cyanide (total)	1,355	1,170

Table 4-2 (continued)

Design and operating parameters:

Parameter	Design value[a]	Operating value							
		SS#1	SS#2	SS#3	SS#4	SS#5	SS#6	SS#7	SS#8
UV output (watts)	5.0	1.9	3.5	5.0	5.0	5.0	5.0	0	5.0
Temperature (°C)	60-68	40-65	63-66	62-66	22-27	66	66	62-68	66
Ozone concentration (wt %)	>3.0	3.5	3.0	3.0	3.0-3.1	3.0	0	3.0	2.5-4.0
Gas flow rate (l/min)	0.5	0.5	0.5	0.5	0.5	0.2-0.5	0	0.5	0.25-0.5
Time (hr)	1	1	1	1	1.1	1.1	1	1	1
pH	8 or 10-12	10.5-11.8	10.6	10.4	10.8-11.3	8.0	8.0	8.0	8.0

[a]Design values were varied for each sample set to determine the effect of these variables on the treated waste cyanide concentration.

Reference: IITRI 1989.

Table 4-3 Chemical Precipitation Treatment Performance Data for K062 - EPA-Collected Data

Sample Set #1

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 805	Treated waste (wastewater) (mg/l) Sample no. 806
Arsenic	3	<1	<1	<0.1
Cadmium	<5	<5	13	<0.5
Chromium (hexavalent)	I	I	893	0.011
Chromium (total)	1800	7000	2581	0.12
Copper	865	306	138	0.21
Lead	<10	<10	64	<0.01
Nickel	3200	2600	471	0.33
Zinc	<2	<2	116	0.125

Design and Operating Parameters

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-3 (continued)

Sample Set #2

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 813	Treated waste (wastewater) (mg/l) Sample no. 814
Arsenic	3	<1	<1	<0.1
Cadmium	<5	<5	10	<0.5
Chromium (hexavalent)	I	I	807	0.12
Chromium (total)	1800	7000	2279	0.19
Copper	865	306	133	0.15
Lead	<10	<10	54	<0.01
Nickel	3200	2600	470	0.33
Zinc	<2	<2	4	0.115

Design and Operating Parameters

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-3 (continued)

Sample Set #3

Constituent	Untreated K062 waste (mg/l) Sample no. 817	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 821	Treated waste (wastewater) (mg/l) Sample no. 822
Arsenic	3	<1	<1	<0.1
Cadmium	<5	<5	5	<0.5
Chromium (hexavalent)	I	I	775	I
Chromium (total)	1700	7000	1990	0.20
Copper	425	306	133	0.21
Lead	<10	<10	<10	<0.01
Nickel	100310	2600	16330	0.33
Zinc	7	<2	3.9	0.140

Design and Operating Parameters

	Design value	Operating value
pH	8-10	10

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-3 (continued)

Sample Set #4

Constituent	Untreated K062 waste (mg/l) Sample no. 827	Untreated K062 waste (mg/l) Sample no. 802	Untreated K062 waste (mg/l) Sample no. 817	Untreated waste composite[a] (mg/l) Sample no. 829	Treated waste (wastewater) (mg/l) Sample no. 830
Arsenic	2	<1	3	<1	<1
Cadmium	<5	<5	5	<5	<0.5
Chromium (hexavalent)	1	I	I	0.6	0.042
Chromium (total)	142	7000	1700	556	0.10
Copper	42	306	425	88	0.07
Lead	<10	<10	<10	<10	<0.01
Nickel	650	2600	41000	6610	0.33
Zinc	3	<2	7	84	1.62

Design and Operating Parameters

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-3 (continued)

Sample Set #5

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated K062 waste (mg/l) Sample no. 817	Untreated waste composite[a] (mg/l) Sample no. 837	Treated waste (wastewater) (mg/l) Sample no. 838
Arsenic	3	<1	3	<1	<0.1
Cadmium	<5	<5	5	<5	<0.5
Chromium (hexavalent)	I	I	I	917	0.058
Chromium (total)	1800	7000	1700	2236	0.11
Copper	865	306	425	91	0.14
Lead	<10	<10	<10	18	0.01
Nickel	3200	2600	41000	1414	0.31
Zinc	<2	<2	7	71	0.125

Design and Operating Parameters

	Design value	Operating value
pH	8-10	8

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-3 (continued)

Sample Set #6

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 845	Treated waste (wastewater) (mg/l) Sample no. 846
Arsenic	3	<1	<1	<0.1
Cadmium	<5	<5	<5	<0.5
Chromium (hexavalent)	I	I	734	I
Chromium (total)	1800	7000	2548	0.10
Copper	865	306	149	0.12
Lead	<10	<10	<10	<0.01
Nickel	3200	2600	588	0.33
Zinc	<2	<2	4	0.095

Design and Operating Parameters

	Design value	Operating value
pH	8-10	8

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-3 (continued)

Sample Set #7

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 853	Treated waste (wastewater) (mg/l) Sample no. 854
Arsenic	3	<1	<1	<0.1
Cadmium	<5	<5	10	<0.5
Chromium (hexavalent)	I	I	769	0.12
Chromium (total)	1800	7000	2314	0.12
Copper	865	306	72	0.16
Lead	<10	<10	108	<0.01
Nickel	3200	2600	426	0.40
Zinc	<2	<2	171	0.115

Design and Operating Parameters

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-3 (continued)

Sample Set #8

Constituent	Untreated K062 waste (mg/l) Sample no. 859	Untreated K062 waste (mg/l) Sample no. 801	Untreated waste composite[a] (mg/l) Sample no. 861	Treated waste (wastewater) (mg/l) Sample no. 862
Arsenic	<1	3	<1	<0.1
Cadmium	<5	<5	<5	<0.5
Chromium (hexavalent)	0.220	I	0.13	<0.01
Chromium (total)	15	1800	831	0.15
Copper	151	865	217	0.16
Lead	<10	<10	212	<0.01
Nickel	90	3200	669	0.36
Zinc	7	9	151	0.13

Design and Operating Parameters

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-3 (continued)

Sample Set #9

Constituent	Untreated K062 waste (mg/l) Sample no. 867	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 802	Untreated waste composite[a] (mg/l) Sample no. 869	Treated waste (wastewater) (mg/l) Sample no. 870
Arsenic	<0.1	3	<1	<1	<0.1
Cadmium	<0.5	<5	<5	<5	<0.5
Chromium (hexavalent)	0.079	I	I	0.07	0.041
Chromium (total)	6	1800	7000	939	0.10
Copper	5	865	306	225	0.08
Lead	<1	<10	<10	<10	<0.01
Nickel	4	3200	2600	940	0.33
Zinc	0.4	<2	<2	5	0.06

Design and Operating Parameters

	Design value	Operating value
pH	8-10	10

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-3 (continued)

Sample Set #10

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated waste composite[a] (mg/l) Sample no. 885	Treated waste (wastewater) (mg/l) Sample no. 862
Arsenic	<3	<1	<0.10
Cadmium	<5	<5	<0.5
Chromium (hexavalent)	I	0.08	0.106
Chromium (total)	1800	395	0.12
Copper	865	191	0.14
Lead	<10	<10	<0.01
Nickel	3200	712	0.33
Zinc	<2	5	0.070

Design and Operating Parameters

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-3 (continued)

Sample Set #11

Constituent	Untreated K062 waste (mg/l) Sample no. 801	Untreated K062 waste (mg/l) Sample no. 859	Untreated waste composite[a] (mg/l) Sample no. 893	Treated waste (wastewater) (mg/l) Sample no. 894
Arsenic	3	<1	<1	<0.10
Cadmium	<5	<5	23	<5
Chromium (hexavalent)	I	0.220	0.30	<0.01
Chromium (total)	1800	15	617	0.18
Copper	865	151	137	0.24
Lead	<10	<10	136	<0.01
Nickel	3200	90	382	0.39
Zinc	<2	7	135	0.100

Design and Operating Parameters

	Design value	Operating value
pH	8-10	9

I = Color interference.

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

Reference: USEPA 1988b.

Table 4-4 Treatment Performance Data for Stabilization of F006 Waste

Source	Oil and grease (mg/kg)	TOC (mg/kg)	Mix ratio[a]	Metal concentrations (ppm)										
				Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Unknown														
Unstabilized														
As received	1,520	14,600		-	36.4	1.3	1270	40.2	35.5	-	435	-	2.3	1560
TCLP				<0.01	0.08	0.01	0.34	0.15	0.26	<0.001	0.71	<0.01	0.01	0.16
Stabilized														
TCLP			0.2	<0.01	0.12	0.01	0.51	0.20	0.30	<0.001	0.04	0.06	0.03	0.03
Auto parts manufacturing														
Unstabilized														
As received	60	1,500		-	21.6	31.3	755	7030	409	-	989	-	6.62	4020
TCLP				<0.01	0.32	2.21	0.76	368	10.7	<0.001	22.7	<0.01	0.14	219
Stabilized														
TCLP			0.2	<0.01	0.50	0.50	0.40	5.4	0.40	<0.001	1.5	0.06	0.03	36.9
TCLP			0.5	<0.01	0.42	0.01	0.39	0.25	0.36	<0.001	0.03	0.11	0.05	0.01
Aircraft overhauling facility														
Unstabilized														
As received	37,000	137,000		-	85.5	67.3	716	693	25.7	-	259	-	39	631
TCLP				0.01	1.41	1.13	0.43	1.33	0.26	<0.001	1.1	<0.01	0.02	5.41
Stabilized														
TCLP			0.2	<0.01	0.33	0.06	0.08	1.64	0.03	<0.001	0.23	0.07	0.20	0.05
TCLP			0.5	<0.01	0.31	0.02	0.20	1.84	0.41	<0.001	0.15	0.11	0.05	0.03
Aerospace manufacturing (mixture of F006 & F007)														
Unstabilized														
As received	3,870	8,280		-	0.74	1.69	12.9	18.5	11.4	-	234	-	6.26	8.86
TCLP				<0.01	0.83	0.66	7.58	4.12	6.86	0.003	158	<0.01	1.64	2.28
Stabilized														
TCLP			1.0	<0.01	0.52	<0.01	0.40	0.23	0.20	<0.001	4.35	0.17	0.09	0.05
TCLP			1.5	<0.01	1.18	0.01	0.34	0.19	0.36	<0.001	2.47	0.20	0.15	0.03

Table 4-4 (continued)

Source	Oil and grease (mg/kg)	TOC (mg/kg)	Mix ratio[a]	Metal concentrations (ppm)									
				Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Zinc plating														
Unstabilized														
As receiuved	1,150	21,200		-	17.2	1.30	110	1,510	88.5	-	37	-	9.05	90,200
TCLP				-	0.84	0.22	0.18	4.6	0.45	<0.001	0.52	-	0.16	2,030
Stabilized														
TCLP			0.2	<0.01	0.20	0.01	0.23	0.30	0.30	<0.001	0.10	0.08	0.03	32
TCLP			0.5	<0.01	0.23	0.01	0.30	0.27	0.34	<0.001	0.02	0.14	0.04	0.04
Unknown														
Unstabilized														
As received	20,300	28,600		-	14.3	720	12,200	160	52	-	701	-	5.28	35,900
TCLP				<0.01	0.38	23.6	25.3	1.14	0.45	<0.001	9.78	<0.01	0.08	867
Stabilized														
TCLP			0.2	<0.01	0.31	3.23	0.25	0.20	0.24	<0.001	0.53	0.04	0.04	3.4
TCLP			0.5	<0.01	0.19	0.01	0.38	0.29	0.36	<0.001	0.04	0.09	0.06	0.03
Small engine manufacturing														
Unstabilized														
As received	2,770	6,550		-	24.5	7.28	3,100	1,220	113	-	19,400	-	4.08	27,800
TCLP				<0.01	0.07	0.3	38.7	31.7	3.37	0.003	730	<0.01	0.12	1,200
Stabilized														
TCLP			0.2	<0.01	0.30	0.02	0.21	0.21	0.30	<0.001	16.5	0.05	0.03	36.3
TCLP			0.5	<0.01	0.33	0.01	0.76	0.20	0.36	<0.001	0.05	0.11	0.05	0.04
Circuit board manufacturing[b]														
Unstabilized														
As received	130	550		-	12.6	5.39	42,900	10,600	156	-	13,000	-	12.5	120
TCLP				<0.01	0.04	0.06	360	8.69	1.0	<0.001	152	<0.01	0.05	0.62
Stabilized														
TCLP			0.2	<0.01	0.04	0.01	3.0	0.40	0.30	<0.001	0.40	0.04	0.03	0.02
TCLP			0.5	<0.01	0.14	0.01	1.21	0.42	0.38	<0.001	0.10	0.07	0.05	0.01

Table 4-4 (continued)

Source	Oil and grease (mg/kg)	TOC (mg/kg)	Mix ratio[a]	Metal concentrations (ppm)										
				Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Zinc
Unknown														
Unstabilized														
As received	30	10,700		-	15.3	5.81	47.9	17,600	169	-	23,700	-	8.11	15,700
TCLP				<0.01	0.53	0.18	0.04	483	4.22	<0.001	644	<0.01	0.31	650
Stabilized														
TCLP			0.2	<0.01	0.32	0.01	0.10	0.50	0.31	<0.001	15.7	0.07	0.03	4.54
TCLP			0.5	<0.01	0.27	0.01	0.2	0.32	0.37	<0.001	0.04	0.07	0.05	0.02
Unknown														
Unstabilized														
As received	1,430	5,960		-	19.2	5.04	644	28,400	24,500	-	5,730	-	19.1	322
TCLP				0.88	0.28	0.01	0.01	16.9	50.2	<0.001	16.1	<0.45	<0.01	1.29
Stabilized														
TCLP			0.2	<0.02	0.19	<0.01	0.03	3.18	2.39	<0.001	1.09	<0.01	<0.01	0.07
TCLP			0.5	<0.02	0.08	<0.01	0.21	0.46	0.27	<0.001	0.02	<0.01	<0.01	<0.01

[a] Mix ratio = $\frac{\text{weight of reagent}}{\text{weight of waste}}$

[b] Circuit board manufacturing waste is not in its entirety defined as F006; however, an integral part of the manufacturing operation is electroplating. Treatment residuals generated from treatment of these electroplating wastes are F006.

Reference: CWM 1987.

5. IDENTIFICATION OF THE BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

This section presents the rationale for the determination of best demonstrated available technology (BDAT) for treatment of F019 wastes. For both cyanide and metals treatment, the Agency has examined all of the available data for the demonstrated technologies to determine whether one of the technologies performed significantly better than the others. Next, the "best" performing treatment technology has been evaluated to determine whether the resulting treatment is available. To be "available," a technology (1) must provide substantial treatment and (2) must be commercially available to the affected industry. If the best demonstrated technology is "available," then this technology represents BDAT.

5.1 BDAT for Treatment of Cyanide

Section 4 presents data for treatment of F019 by wet air oxidation followed by filtration (Table 4-1). These data show significant reduction in the concentrations of amenable and total cyanide in both the wastewater filtrate and nonwastewater filter cake generated. Table 4-2 presents data on UV/ozonation treatment of an F009 waste that was generated following alkaline chlorination treatment and thus had a high concentration of complexed cyanide. However, the UV/ozonation treatment data were not directly comparable to the wet air oxidation data because the "treated waste" data do not reflect settling and/or filtration to separate solids and generate wastewater and nonwastewater residuals. Therefore, these data were not considered in further development of the BDAT treatment standards for F019 wastes.

EPA has no other data for treatment of cyanide in F019 wastes or similar wastes; therefore, the Agency has determined that wet air oxidation represents "best" treatment for cyanide in F019 wastes. Wet

air oxidation is "available" because it is a commercially available technology and provides substantial treatment. Therefore, wet air oxidation represents BDAT for cyanide in F019 waste (both nonwastewaters and wastewaters). Summaries of the accuracy adjustment of treatment data for total and amenable cyanide in F019 wastes are presented in Tables 5-1 and 5-2, respectively (at the end of this section).

5.2 BDAT for Treatment of Metals

Treatment of F019 wastes for cyanide destruction by wet air oxidation generates both wastewater and nonwastewater residuals that require further treatment for BDAT list metals.

5.2.1 Wastewaters

No treatment data are available for treatment of metals in F019 wastewaters. EPA does, however, have treatment data for wastes (K062) believed to be similar to F019 wastewaters in terms of the type and concentration of BDAT list metals present and in terms of waste characteristics affecting treatment performance (as discussed in Section 4.2.1). These treatment data are based on chemical reduction followed by chemical precipitation and filtration. The Agency determined that the treatment performance data for K062 represented a well-designed, well-operated treatment system (see Table 5-3).

The treatment data for chemical reduction followed by chemical precipitation and filtration have been determined to represent "best" treatment, based on evaluation of all data data available to the Agency for treatment of wastewaters containing high concentrations of chromium at the time of promulgation of the First Third land disposal restrictions (USEPA 1988b). Since that time, EPA has found no data on treatment of chromium-containing wastewaters by the BDAT technology for K062 or by any

other technology. This technology is "available" because it provides substantial treatment of BDAT list metals and the individual processes are each commercially available. Therefore, chemical reduction of hexavalent chromium followed by chemical precipitation and filtration represents BDAT for BDAT list metals in F019 wastewaters.

5.2.2 Nonwastewaters

No treatment data are available to the Agency for treatment of metals in F019 nonwastewaters. EPA does, however, have stabilization data for metal-containing nonwastewater treatment sludges (F006) believed to be similar to F019 nonwastewaters generated as a residual following cyanide treatment (as discussed in Section 4.2.2). The Agency determined that the treatment performance data for F006 stabilization represent a well-designed and well-operated treatment system (USEPA 1988a).

The stabilization data for F006 show TCLP chromium concentration is reduced from up to 360 mg/l in the untreated waste down to less than 1.5 mg/l in the stabilized waste (see Table 5-4).

The Agency has no reason to believe that the use of other processes could improve the level of performance achieved by stabilization. Therefore, stabilization is "best." This treatment system is "available" because the components of the treatment system are commercially available and provide substantial treatment. Therefore, stabilization represents BDAT for BDAT list metals in F019 wastewater treatment sludges and also in the nonwastewater residuals from treatment of F019 by wet air oxidation followed by chemical reduction, chemical precipitation, and filtration. The accuracy-corrected performance data used to develop metals treatment standards for F019 are presented in Tables 5-3 and 5-4.

Table 5-1 Summary of Accuracy Adjustment of Treatment Data for Total Cyanide in F019

	Untreated waste concentration (mg/l)	Measured treated waste concentration (mg/l)	Percent recovery for matrix spike test	Accuracy-correction factor	Accuracy-adjusted concentration (mg/l)
Wastewater					
Sample Set No. 1	293	5.07	52	1.923	9.75
Sample Set No. 2	293	0.058	52	1.923	0.112
Sample Set No. 3	293	0.133	52	1.923	0.256
Nonwastewater					
Sample Set No. 1	293	22.9	52	1.923	44.0
Sample Set No. 2	293	142	52	1.923	273
Sample Set No. 3	293	18	52	1.923	34.6

Table 5-2 Summary of Accuracy Adjustment of Treatment Data for Amenable Cyanide in F019

	Untreated waste concentration (mg/l)	Measured treated waste concentration (mg/l)	Percent recovery for matrix spike test	Accuracy-correction factor	Accuracy-adjusted concentration (mg/l)
Wastewater					
Sample Set No. 1	241	5.0	52	1.923	9.6
Sample Set No. 2	241	<0.02	52	1.923	<0.0385
Sample Set No. 3	241	<0.02	52	1.923	<0.0385
Nonwastewater					
Sample Set No. 1	241	22.9	52	1.923	44.0
Sample Set No. 2	241	142	52	1.923	273
Sample Set No. 3	241	18	52	1.923	34.6

Table 5-3 Accuracy-Corrected Performance Data for Chromium in K062 Wastewaters

	Untreated waste composite[a] (mg/l)	Treated waste (mg/l)	Percent recovery[b]	Correction factor	Corrected value (mg/l)
Sample Set No. 1	2581	0.12	68	1.47	0.1764
Sample Set No. 2	2279	0.12			0.1764
Sample Set No. 3	1990	0.20			0.294
Sample Set No. 4	556	0.10			0.147
Sample Set No. 5	2236	0.11			0.162
Sample Set No. 6	2548	0.10			0.147
Sample Set No. 7	2314	0.12			0.1764
Sample Set No. 8	831	0.15			0.2205
Sample Set No. 9	939	0.10			0.147
Sample Set No. 10	395	0.12			0.1764
Sample Set No. 11	617	0.18			0.2646

[a]The untreated waste composite is a mixture of the untreated K062 waste streams shown on this table, along with other non-K062 waste streams.

[b]The percent recovery has been taken from Table 7-14 of the Onsite Engineering Report from Horsehead Resource Development Company (USEPA 1987).

Reference: USEPA 1988b.

Table 5-4 Accuracy-Corrected Performance Data for Chromium in F006 Nonwastewaters by Stabilization

Source	Mix ratio[a]	Untreated waste concentration as received (mg/l)	Untreated waste concentration (TCLP) (mg/l)	Accuracy-adjusted treated waste concentration (TCLP) (mg/l)
Auto part manufacturing	0.5	755	0.76	0.45
Aircraft overhauling	0.2	716	0.43	0.09
Unknown	0.5	12,200	25.3	0.44
Small engine manufacturing	0.5	3,100	38.7	0.89
Circuit board manufacturing	0.5	42,900	360	1.41

[a] $\text{mix ratio} = \frac{\text{weight of reagent}}{\text{weight of waste}}$

Source: USEPA 1988a.

6. SELECTION OF REGULATED CONSTITUENTS

As discussed in EPA's Methodology for Developing BDAT Treatment Standards (USEPA 1989a), the Agency has developed a list of BDAT hazardous constituents from which the constituents to be regulated are selected. EPA may revise this list as additional data and information become available. The list is divided into the following categories: volatile organics, semivolatile organics, metals, inorganics other than metals, organochlorine pesticides, phenoxyacetic acid herbicides, organophosphorus insecticides, PCBs, and dioxins and furans.

This section describes the process used to select the constituents to be regulated. The process involves developing a list of potential regulated constituents and then eliminating those constituents that would not be treated by the chosen BDAT or that would be controlled by regulation of other constituents in the waste.

6.1 Identification of BDAT List Constituents in F019

As discussed in Sections 2 and 4, the Agency has characterization data and performance data for the treatment of F019. These characterization data and performance data have been used to determine which BDAT list constituents may be present in the waste and thus which ones are potential candidates for regulation.

6.2 Constituents Selected for Regulation

Based on the characterization and performance data for F019 presented in Sections 2 and 4, the Agency is proposing to regulate total cyanide, amenable cyanide, and total chromium. These are the Appendix VIII constituents for which the waste was listed. Based on EPA's knowledge of the chemical conversion coating process, the Agency would not expect any

other BDAT list constituents to be commonly found in these wastes at treatable concentrations. The only other BDAT list constituents expected to be present in F019 would be other BDAT list metals. These constituents are expected to be found, if at all, at much lower concentrations than chromium. Nickel and zinc were detected at greater than 1,000 ppm in two of the F019 wastes for which characterization data were given. These metals, when detected in this waste, are expected to be treated by a well-designed and well-operated BDAT treatment system for both nonwastewaters and wastewaters.

7. CALCULATION OF BDAT TREATMENT STANDARDS

This section presents the calculation of the BDAT treatment standards for the regulated constituents determined in Section 6. As discussed in the Methodology for Developing BDAT Treatment Standards (USEPA 1989a), the following steps were taken to derive the BDAT treatment standards for F019.

The Agency evaluated the three data sets collected from wet air oxidation testing of F019 to determine whether any of the data represent poor design or poor operation of the treatment system. The available data show that the concentration of cyanide in the first treated wastewater sample (Sample Set No. 1) was much higher than the cyanide concentration in the other two sample sets. EPA believes that the higher temperatures used for Sample Sets 2 and 3 resulted in better cyanide treatment. Hence, one of the data sets represents poor design or poor operation. Two of the three data sets for wet air oxidation of F019 (240°C and 280°C) were used to establish treatment standards for the regulation of cyanide in F019 wastes.

For BDAT list metal constituents, the treatment standards for nonwastewaters are based on transfer of performance data from stabilization of F006 wastewater treatment sludges and the treatment standards for wastewaters are based on transfer of performance data from treatment of K062 wastes by chemical reduction followed by chemical precipitation and filtration. It was previously determined in the associated background documents (USEPA 1988a, USEPA 1988b) that the data used in development of treatment standards for these wastes represented the performance of well-designed, well-operated treatment systems.

As described in the methodology, analytical accuracy-corrected constituent concentrations were calculated for all regulated BDAT list constituents. An arithmetic average of concentration levels for each

constituent and a variability factor for each constituent were then determined. The variability factor represents the variability inherent in the treatment process and the sampling and analytical methods. Variability factors are calculated based on the treatment data for each of the regulated constituents. The general methodology for calculating variability factors is presented in Appendix A of the methodology document.

The BDAT treatment standard for each constituent proposed to be regulated in this rulemaking was determined by multiplying the average accuracy-corrected total composition by the appropriate variability factor. The calculation of treatment standards for cyanide is shown in Table 7-1; the calculation of the treatment standards for chromium is presented in Table 7-2. The proposed treatment standards are shown in Table 7-3.

Table 7-1 Calculation of Cyanide Treatment Standards for F019

	Arithmetic average of corrected treatment values (mg/kg)	Variability factor	Treatment standard (mg/kg)
Wastewater			
Cyanide (amenable)	<0.0385	2.8	0.11
Cyanide (total)	0.184	1.5	0.27
Nonwastewater			
Cyanide (amenable)	153.8	2.55	390
Cyanide (total)	153.8	2.55	390

Table 7-2 Calculation of BDAT List Metals Treatment Standards for F019

	Arithmetic average of corrected treatment values (mg/kg)	Variability factor	Treatment standard (mg/kg)
Wastewater			
Chromium (total)	0.19	1.69	0.32
Nonwastewater			
Chromium (total)	0.66	7.94	5.2

Table 7-3 Proposed BDAT Treatment Standards for F019

Constituent	Maximum for any single grab sample		
	Nonwastewater		Wastewater
	Total concentration (mg/kg)	TCLP leachate concentration (mg/l)	Total concentration (mg/l)
Cyanide (amenable)	390	NA	0.11
Cyanide (total)	390	NA	0.27
Chromium (total)	NA	5.2	0.32

NA = Not applicable.

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APPENDIX A

ANALYTICAL QA/QC

Table A-1 Matrix Spike/Matrix Spike Duplicate Results for Cyanide from Wet Air Oxidation Treatment of F007 Waste

Sample number	Sample conc. (ug/l)	Spike added (ug/l)	Spike result (ug/l)	% Recovery	Spike duplicate result (ug/l)	% Recovery	RPD
OL-03	16.11	24.75	29.16	52.7	28.97	52.0	0.7

OL-03 = Treated waste sample; Sample Set No. 3.

$$RPD = 100 \text{ (spike result - spike duplicate result)} / \frac{\text{(spike result + spike duplicate result)}}{2}$$

Reference: USEPA 1988c.

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